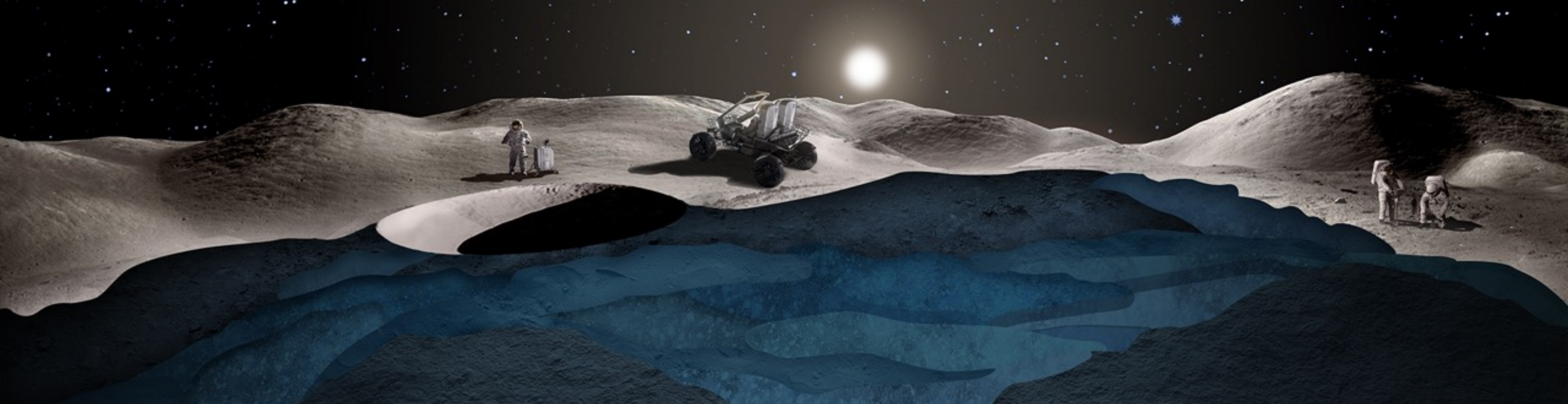
National Aeronautics and
Space Administration

Artemis III Science Definition Team

Community Town Hall

October 22, 2020



The SDT will:

- Define compelling and executable science objectives for the Artemis III mission, the first human mission to the surface of the Moon in the 21st century.
- Assess objectives for the mission to achieve the science goals articulated by NASA including investigation approaches, key surface science activities, and potential inputs into the concept of operations.
- Submit a final report to the Planetary Science Division that contains prioritized science objectives for all aspects of the Artemis III mission, including sampling strategies and science goals and priorities of deployable instrument packages.

Membership

Co-chairs:
- Renee Weber, NASA MSFC
- Barbara Cohen, NASA GSFC
- Sam Lawrence, NASA JSC

Community consultants:
- Amy Fagan, LEAG Chair
- Carlé Pieters, SSERVI Distinguished Scientist
- Juliane Gross, CAPTEM Lunar Sample Subcommittee Chair

Executive Secretary
- Amanda Nahm, SMD PSD

Civil Servant Members:
- Jeremy Boyce, NASA JSC
- Michael Collier, NASA GSFC
- Caleb Fassett, NASA MSFC
- Lisa Gaddis, USGS Astrogeology
- John Gruener, NASA JSC
- Jennifer Heldmann, NASA ARC
- Noah Petro, NASA GSFC
- Kelsey Young, NASA GSFC

Ex officio observers: Sarah Noble (PSD), Debra Needham (ESSIO), James Spann (HPD), Jake Bleacher (HEOMD), David Draper (OCS), Kevin Sato (BPS), Julie Mitchell/Francis McCubbin (JSC curation)

Timeline for Artemis SDT

September

8 White Papers due

10 First meeting

14 Town Hall #1 (LEAG)

October

~~15~~ 16 Draft report released – public comments close Oct 26.

22 Town Hall #2

November

6 Final report submitted

Artemis III Science Definition Team Report

The Beginning of a Bold New Era of Human Discovery

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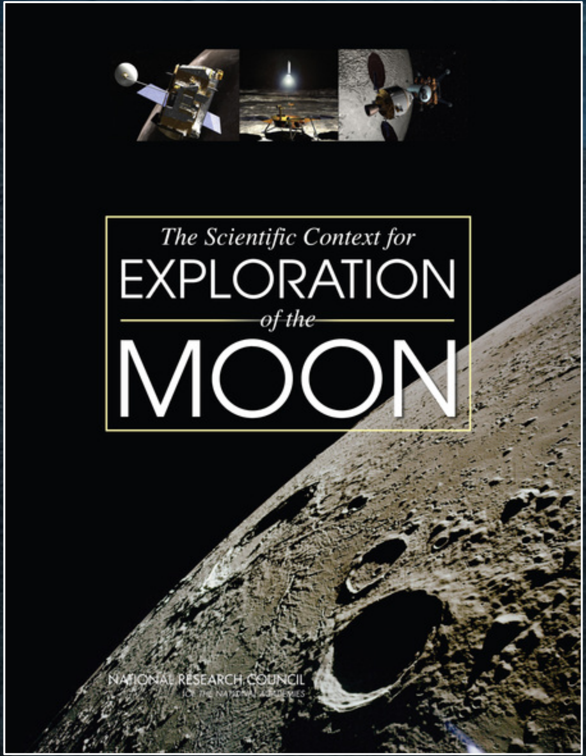
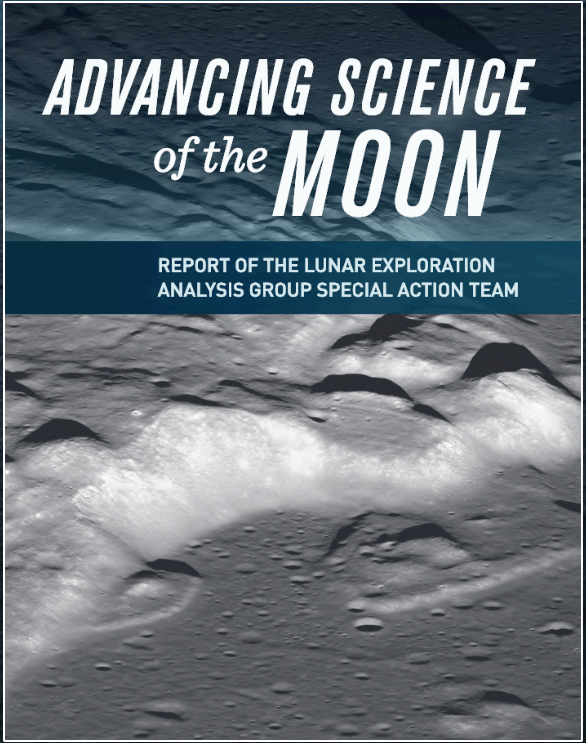
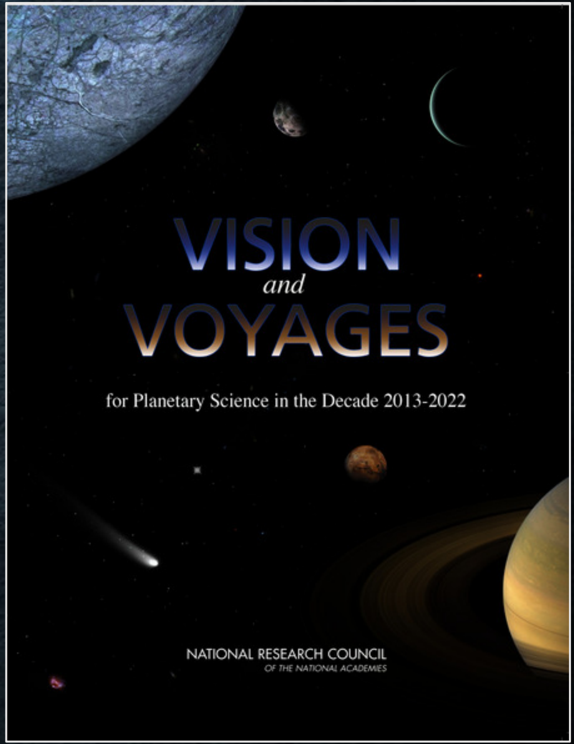
https://www.lpi.usra.edu/Artemis/
https://lunarscience.arc.nasa.gov/artemis-sdt/

3. Overview of Guiding Community Documents







and community-submitted white papers

4. Artemis Program and Architecture Summary

NextSTEP H: Human Landing System

Solicitation Number: NNH19ZCQ001K_APPENDIX-H-HLS

https://www.nasa.gov/nextstep/humanlander2

Table 11: Scientific Payload Delivery

Items	Qty	Mass (kg)	Storage Environment	Geometry	Length (cm)	Height (cm)	Width (cm)	Volume (m3)	Notes
Down Mass Total		**100**							
Science Equipment		80							
long axis of tools such as rakes or drive tubes		60-70	Unpressurized	box	145	165	50	1.2	Tools, cameras and sensors will remain on lunar surface
cameras or other sensors for use in the habitable environment	2	10-20	Pressurized	box	48	38	18	0.06	Dimensions are for each container, 0.06 for both
Sample Return Equipment*		20						0.16	total volume of all containers.
sample return container	2		Pressurized	box	48	30	20		Dimensions are for each container, 0.06 m3 for both
sample return collection bags	7		Pressurized	box	42	22	15		Dimensions are for each container, 0.1 m3 for all

*Sample Return Equipment would be empty during descent and used to carry lunar samples back to Gateway during ascent. During descent, they could be filled with other items. In the event that full return mass goal is not met and the full complement of sample return equipment is not needed, the remainder of the allocation of down mass and volume will be filled with additional science items.

4. Artemis Program and Architecture Summary

Table 10: Scientific Payload Return

Items	Qty	Mass (kg)	Storage Environment	Geometry	Length (cm)	Height (cm)	Width (cm)	Volume (m3)	Notes
Up Mass Total (Goal)		**100**							
Sample Return Equipment		20						0.16	total volume of all containers.
sample return container	2		Pressurized	box	48	30	20		Dimensions are for each container, 0.06 m3 for both
sample return collection bags	7		Pressurized	box	42	22	15		Dimensions are for each container, 0.1 m3 for all
Lunar Samples		80	Pressurized						would be contained in the Sampler Return volumes above
Up Mass Total (Threshold)		**35**							
Sample Return Equipment		9						0.07	total volume of all containers.
sample return container	1		Pressurized	box	48	30	20		Dimensions are for each container
sample return collection bags	3		Pressurized	box	42	22	15		Dimensions are for each container
Lunar Samples		26	Pressurized						would be contained in the Sampler Return volumes above

Note: Orion does not have specific storage to match the HLS sample return volume. Sample return mass to Eath via Orion might require mission-by-mission decisions on storage within Orion and possible considerations for different sample return container/bag design.

5. Artemis Science Objectives and Traceability to Science Priorities

Objective 1: Understanding Planetary Processes

Objective 2: Understanding the Character and Origin of Lunar Volatiles

Objective 3: Interpreting the Impact History of the Earth-Moon system

Objective 4: Revealing the Record of the Ancient Sun and Our Astronomical Environment

Objective 5: Observing the Universe and the Local Space Environment from a Unique Location

Objective 6: Conducting Experimental Science in the Lunar Environment

Objective 7: Investigating and Mitigating Exploration Risks

The SDT was charged with expanding upon science these Objectives, first laid out in the Artemis Plan. To do so, we chose to map science Goals (areas of research) down to Investigations (specific activities undertaken to address Goals).

Prioritization process (preliminary)

Objectives – Goals – Investigations

The SDT undertook prioritization at the Investigation level. Each investigation was ranked (preliminary) on two independent criteria mirroring process used in guiding documents:

- Compelling science (e.g., how fundamental is the investigation to making a significant scientific advancement)
- Whether Artemis III presents an enabling opportunity given the architectural implications mentioned earlier.

Both the traceability and the prioritization mirror our guiding documents and the community-submitted white papers.

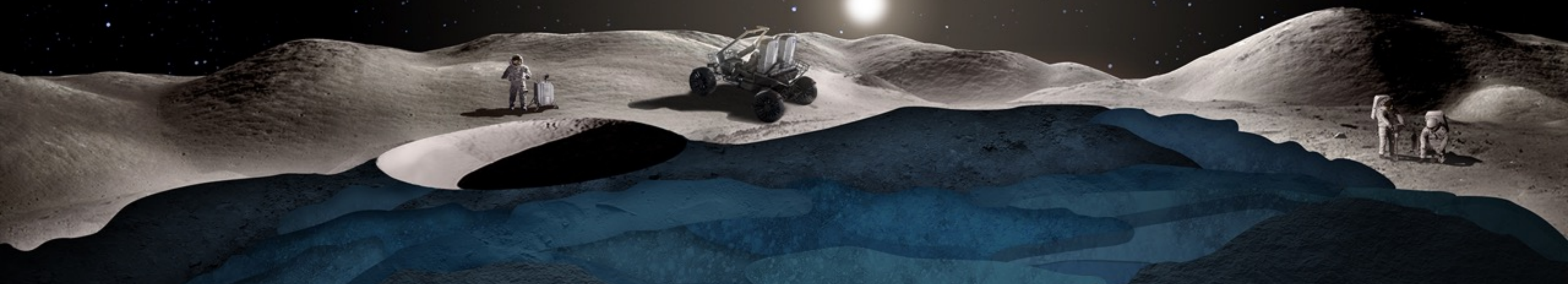
Artemis Science Objective	Science Goal	Science Investigation	Traceability	Science Priority	Enabled by Artemis III
2. Understanding the Character and Origin of Lunar Polar Volatiles	2d. Understand regolith modification processes (including space weathering), particularly deposition of volatile materials in the near surface.	Examine soils from special regions (e.g., paleoregoliths, shadowed, fresh craters, swirls, etc.) to understand regolith modification processes, including space weathering	SCEM 4d ASM-1, 4b, 4c, 7c, 8d LER Investigation-Sci-A3 LER Investigation Sci-A-4E	L	Y
3. Interpreting the Impact History of the Earth-Moon System	3a. Test the Cataclysm	Anchor the earliest recorded impact history of the Moon by determining the age of the oldest lunar basin, South Pole-Aitken	SCEM 1a	H	M
1. Understanding Planetary Processes	1b. Differentiation: magma oceans, crust, and mantle	**1b-2. Determine the bulk composition of the crust and mantle**	LER Investigation-Sci-A-9A LER Investigation-Sci-A-9B LER Investigation-Sci-A-9C	H	Y

6. Cross-objective commonality

Most science objectives for the Artemis III mission have constructive synergies with each other and with the objectives of other mission directorates

- Importance of sample acquisition and handling
- Importance of establishing long-lived experimental stations on the surface
- Feed-forward aspects of Artemis III discoveries towards understanding lunar resource potential, commercial development strategies, and resource utilization efforts
- Applicability of results from Artemis III towards future Artemis missions, the Artemis base camp, and exploration of other destinations (e.g. small bodies; Mars)

7. Enabling capabilities



Power

- Long-lived deployed science experiments, which would address many of the high-priority science Investigations identified here, require operations over time periods longer than the Artemis III surface mission.

Pre-deploy

- Our report presents compelling and executable science investigations for the Artemis III mission based on the architecture as we currently understand it, but the ability to pre-deploy science assets using CLPS landers could dramatically increase the capability of early Artemis landings.

Mobility

- The Artemis III mission does not, as presently formulated, include availability of an unpressurized lunar rover. Pre-deployed assets could however also include mobility systems, which will be vital to the long-term exploration and development of the Moon.

8. Cartographic recommendations

Landing humans near the lunar South Pole and supporting surface operations for Artemis III will require the use of multiple lunar datasets from recent orbital missions. It is essential that each product use standardized and clearly defined geodetic information, consistent reference frames and coordinate systems, and cartographic products with known levels of accuracy and precision.

9. Landing site considerations

The selection of a landing site for the Artemis III mission is outside the scope of the activities of this SDT.

The SDT will suggest factors be considered in the Artemis III site selection process in order to fully inform the ultimate selection of the Artemis III landing site, separately from operational concerns such as block abundance, crater frequency, and slope:

- Sufficient illumination for long-duration solar power stations to enable long-lived surface experiments (if solar power is used);
- Availability of a range of sizes of craters for radial traverses and sampling, which will inform our understanding of the impact process;
- Comprehensive sampling which will inform our understanding of the complex geology of the landing site and its link to both surface and internal processes;
- Accessibility of larger blocks to enable sampling of large crater ejecta;
- Proximity and accessibility of mostly or permanently shadowed regions to understand volatile processes;
- Proximity to multiple geologic units of differing time-stratigraphic age;
- Proximity to geologic units that enable specific, high-priority investigations (SPA and PSRs)
- & TBD based on community input

Next steps

The Science Definition Team will:
1. Summarize community input & feedback on report, further deliberate on prioritization
2. Synthesize science requirements into an Artemis III field campaign consisting of compelling and executable investigations
3. Produce findings and recommendations in the final report (deadline Nov. 6)

NASA/Science Mission Directorate (SMD) will:
1. Use the report to define and scope instrument calls for deployed and astronaut-utilized payloads
2. Use the report to ensure that NASA curation is fully prepared to accept and process the samples to be returned by Artemis III
3. Use the report to inform the generation of mission-enabling data products

SMD will use the report as a foundation for communication with HEOMD on:
1. Development of exploration capabilities and mission requirements
2. Identifying landing site Figures of Merit and informing cross-agency recommendations on site selections.
3. Interfacing with other stakeholders on surface activities (e.g. HRP, STMD, Planetary Protection)

Questions for discussion

https://www.lpi.usra.edu/Artemis/
https://lunarscience.arc.nasa.gov/artemis-sdt/

- To what extent does the report define compelling and executable science objectives for the Artemis III mission? What, if anything, is missing?
- Do you agree with the Goals and Investigations prioritized for Artemis III?
- Do you agree with Enabling Capabilities as presented in the report?
- Do you agree with Landing Site Considerations as presented in the report?
- Do you have any other feedback?